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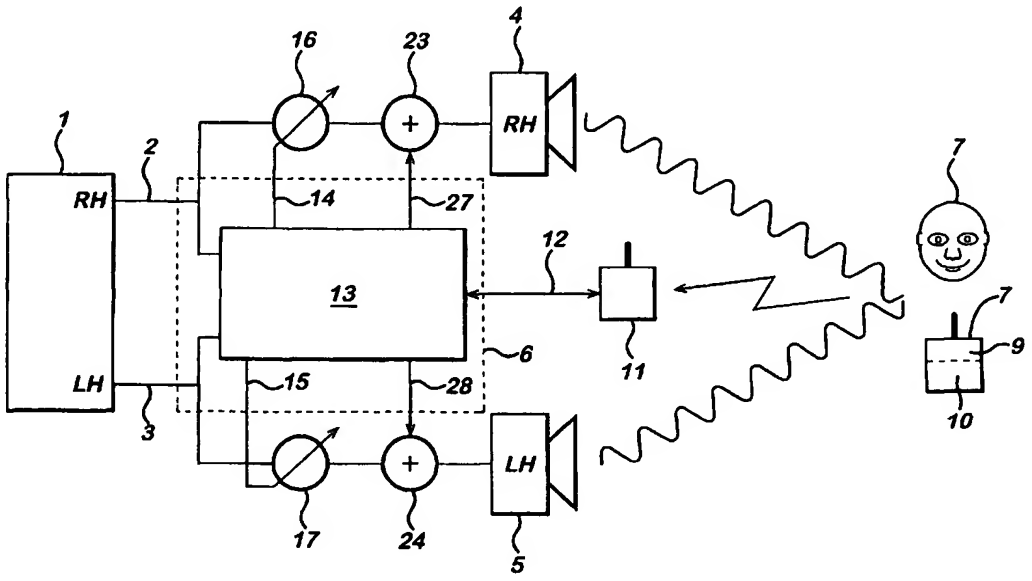
(54) Title: HIGH FIDELITY AUDIO SIGNAL REPRODUCTION SYSTEM AND METHOD OF OPERATION



(57) Abstract: A high fidelity audio signal reproduction system comprises a hi-fi signal generator (1), arranged to feed audio signals to loudspeakers (4,5), via an audio signal processor (6), and an audio signal receiver (8) which in use is co-located with a listener (7) so as to receive sound from the loud speakers which is similar to sound received by the listener. A sample of the received sound is fed back to the processor and compared with the audio signals produced by the hi-fi signal generator. The processor modifies the audio signals applied to the lound speakers in dependence upon the result of this comparison, so that differences between the signals are minimised.

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HIGH FIDELITY AUDIO SIGNAL REPRODUCTION SYSTEM AND METHOD OF OPERATION

This invention relates to hi-fi (high fidelity) audio signal reproduction systems and more especially, but not exclusively, it relates to high fidelity audio amplifier systems.

Audio hi-fi systems generally seek to deliver the best possible sound quality to a listener. A conventional known way to accomplish this is to specify exacting standards for each component of an audio amplifier chain. Whilst this approach is undoubtedly able to deliver extremely good sound quality, it is essentially a static solution, which is unable to adjust dynamically to compensate satisfactorily for sound degradation due to various changing factors including degradation due to component ageing such as speaker cone ageing and environmental factors which influence sound generated by system loud speakers, as radiated sound travels to the ears of a listener. Another method is to sample the output at the loudspeaker and use a feedback mechanism to adjust this. However, neither method deals with changes in sound as it is propagated e.g. across a room to a listener

In accordance with a first aspect of the present invention, a high fidelity audio signal reproduction system comprises a hi-fi signal generator, arranged to feed audio signals to loudspeaker means, via an audio signal processor; an audio signal receiver which in use is co-located with a listener so as to receive sound from the loud speaker means which is similar to sound received by the listener; wherein a sample of the received sound is fed back to the processor; and compared with the audio signals produced by the hi-fi signal generator; wherein the processor modifies the audio signals applied to the loud speaker means in dependence upon the result of this comparison, such that differences between signals at the loudspeaker and the listener are minimised.

In accordance with a second aspect of the present invention, a method of operating a high fidelity audio signal reproduction system comprises feeding audio signals from a hi-fi signal generator to loudspeaker means via an audio signal processor; co-locating an audio signal receiver with a listener so as to receive sound from the loudspeaker means which is similar to sound received by the listener; feeding

back a sample of the received sound to the processor; comparing the sample with the audio signal produced by the hi-fi signal generator; and, modifying the audio signal applied to the loudspeaker means in dependence upon the result of this comparison, such that differences between signals at the loudspeaker and the listener are minimised.

The present invention provides a hi-fi system which can automatically compensate for degradation of the quality of sound heard by a listener, such that system fidelity is improved. A system according to the invention provides a feed-back loop which includes the loud speaker and the sound path environment to the listener, whereby non- linear effects produced therein are compensated for, at least in part, to improve system fidelity. By co-locating the sample receiver with the listener, the sound sample closely reflects the sound received by the listener and can be improved upon accordingly.

In prior art systems, the sample is taken at the loudspeaker itself before any environmental effects have been applied which may alter the sound perceived by the listener, so any corrections cannot compensate for the environmental effects. Alternatively, many samples are taken in a particular room and an estimate of the sound received at any point is made by extrapolating these samples. This can lead to an unsatisfactory sound for the listener, if they are in the wrong position, or else it involves undue effort and expense in taking sufficient samples to ensure that accurate estimates can be obtained for every point in the room.

Preferably, the sound sample is sensed by a microphone and fed back via a wireless communication link to the processor.

Preferably, the system is a stereo system wherein the signals fed to the processor are for left and right stereo channels comprising left and right hand speakers respectively.

Preferably, the processor comprises a signal comparator which serves to provide for each channel phase and amplitude compensation to improve fidelity.

Preferably, the processor includes means for injecting into each channel an inaudible pilot tone, wherein the pilot tone plus audio output from each channel is compared in the comparator with signals returned to the comparator via the communication link.

One embodiment of the present invention will now be described by way of example only with reference to the accompanying drawings in which;

Figure 1 is a block circuit diagram of a high fidelity audio signal reproduction system according to the present invention; and,

Figure 2 is a block circuit diagram of a signal processor which forms a part of the system of Fig. 1.

Figure 1 shows a system comprising a stereo audio signal source 1 which produces audio signals on lines 2, 3 for right and left hand channels respectively. The signals are fed to right and left hand loudspeakers 4, 5 respectively via a signal processor arrangement as shown within a broken line 6.

Audio stereo signals produced by the speakers 4, 5 are received by a listener 7 and co-located with the listener 7,there is provided an audio signal sampler 8, including a microphone 9, which also receives the stereo audio signals. These stereo audio signals as received by the microphone 9 are transmitted via a Bluetooth radio transmitter 10, which is a part of the signal sampler 8, to a complementary Bluetooth radio receiver 11 which feeds the signal processor arrangement 6 on a line 12 to form a feedback loop which includes the loudspeakers 4,5 and the environment, whereby non-linearity produced thereby is compensated for, due in effect, to the well known linearising effects of negative feedback. For this example, reference is made to Bluetooth, but other types of wireless LAN technology are equally suitable such as HIPERLAN and IEE802.11(a and b). Other radio systems can also be used including DECT and bespoke radio links.

The processor arrangement 6 comprises a comparator arrangement 13 which will later be described herein in detail with reference to Fig. 2 which serves to compare the audio feedback signals from the Bluetooth receiver 11 with signals on the lines 2, 3 from the audio signal source 1 and to provide phase/amplitude feedback signals on lines 14, 15 for right and left hand channels respectively, which are applied to signal controllers 16, 17 thereby to apply compensation to the signals fed to the right and left hand speakers 4, 5 respectively.

In Fig. 2 the processor arrangement is shown in more detail. The comparator arrangement 13 comprises a signal comparator 18 to which the stereo signals on the lines 2, 3 are fed for comparison with fed back stereo signals on the line 12, so as to

produce in dependence upon the difference therebetween, feedback signals on lines 19, 20 which supply phase and amplitude signal generators 21, 22 which in turn provide the signals for lines 14, 15 respectively, which drive the signal controllers 16, 17 as shown in Fig. 1.

In order to make the compensation process simpler and more accurate, a pilot tone is added to each channel by means of signal adders 23, 24 which are fed with a suitable inaudible signal tone from pilot tone generators 25, 26 respectively in the comparator arrangement via lines 27, 28 thereby to assist the comparator when the source signals themselves are not suitable for comparison.

Various modifications may be made to the arrangement as just before described without departing from the scope of the invention and for example although Bluetooth is used in this particular example, any suitable feedback technique may be employed to provide for audio feedback between a region adjacent to a listener and the hi-fi system itself. Additionally, it will of course be appreciated that the hi-fi sound source may take any required form and comprise a radio, a CD player, a tape deck, an MP3 player, or a Minidisk player or any combination of these kinds of apparatus which may be chosen in accordance with the particular application, or user requirement in view.

CLAIMS.

1. A high fidelity audio signal reproduction system comprises a hi-fi signal generator (1), arranged to feed audio signals to loudspeaker means (4, 5), via an audio signal processor (6); an audio signal receiver (8) which in use is co-located with a listener (7) so as to receive sound from the loud speaker means which is similar to sound received by the listener; wherein a sample of the received sound is fed back to the processor (6); and compared with the audio signals produced by the hi-fi signal generator (1); wherein the processor modifies the audio signals applied to the loud speaker means (4, 5)in dependence upon the result of this comparison, such that differences between signals at the loudspeaker and the listener are minimised.

2. A high fidelity audio signal reproduction system as claimed in claim 1, wherein the sound sample is sensed by a microphone (9) and fed back via a wireless communication link to the processor (6).

3. A high fidelity audio signal reproduction system as claimed in any preceding claim wherein the system is a stereo system wherein the signals fed to the processor are for left and right stereo channels which comprise left and right speakers..

4. A high fidelity audio signal reproduction system as claimed in claim 3, wherein the processor comprises a signal comparator (18) serves to provide for each channel phase and amplitude compensation to thereby improve fidelity.

5. A high fidelity audio signal reproduction system as claimed in claim 4, wherein the processor (6) includes means for injecting into each channel an inaudible pilot tone.

6. A high fidelity audio signal reproduction system as claimed in claim 5, wherein the pilot tone plus audio output from each channel is compared in the comparator with the signal returned to the comparator (18) via the communication link.

7. A method of operating a high fidelity audio signal reproduction system, the method comprising feeding audio signals from a hi-fi signal generator (1) to loudspeaker means (4, 5) via an audio signal processor (6); co-locating an audio signal receiver (8) with a listener (7) so as to receive sound from the loudspeaker means which is similar to sound received by the listener; feeding back a sample of the received sound to the processor; comparing the sample with the audio signal produced by the hi-fi signal generator; and, modifying the audio signal applied to the loudspeaker means in dependence upon the result of this comparison, such that differences between signals at the loudspeaker and the listener are minimised.

Fig. 1

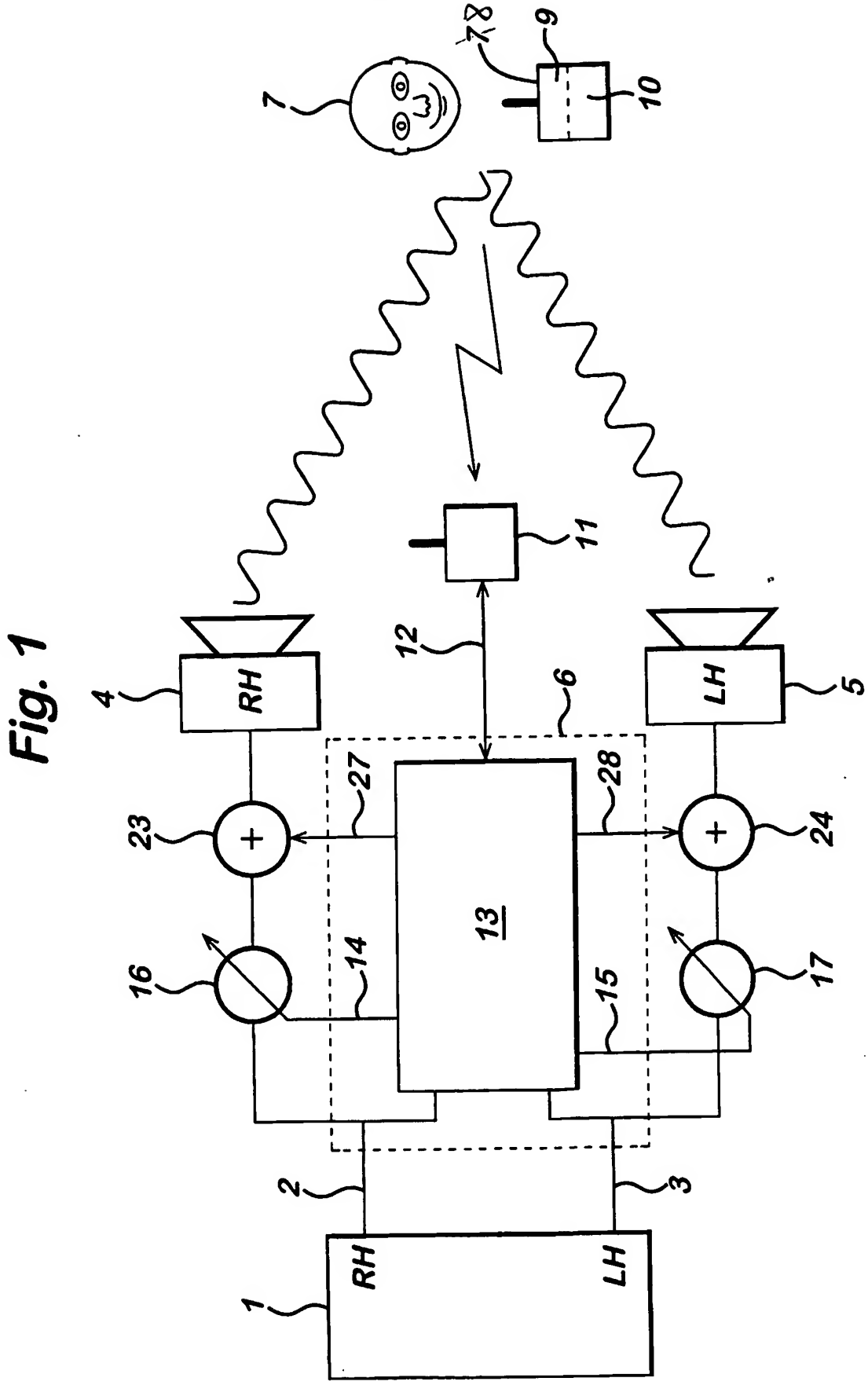

Fig. 2